

WBS 1.3 IST Overview

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IST presentation overview



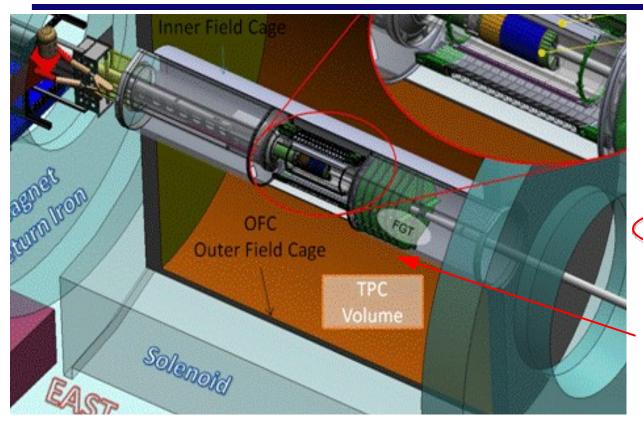
- Detector overview
- CD-4 requirements and deliverables
- Technical description and design status
- Fabrication and testing
- Subsystem cost
- Human resources
- Milestones and risk assessment





IST in Inner Detector Upgrade STAR HET





TPC – Time Projection Chamber (main tracking detector in STAR)

HFT – Heavy Flavor Tracker

- SSD Silicon Strip Detector
 - r = 22 cm
- IST Inner Silicon Tracker
 - r = 14 cm
- PXL Pixel Detector
 - r = 2.5, 8 cm

FGT – Forward GEM Tracker Shares almost identical readout system with IST Installation in CY2011

We track inward from the TPC with graded resolution:

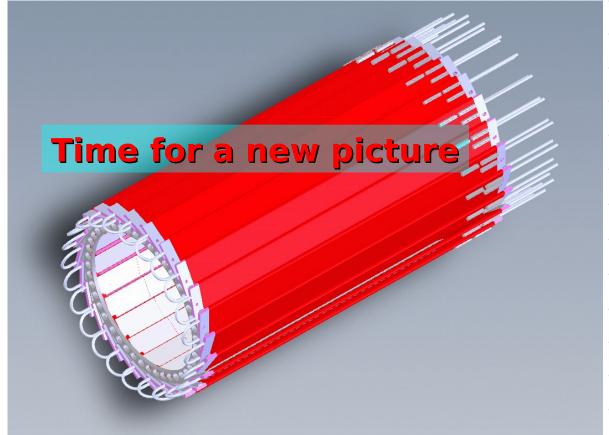






IST overview





Radius	14cm
Length	50ст
φ-Coverage	2π
η -Coverage	≤1.2
Number of ladders	24
Number of hybrids	24
Number of sensors	144
Number of readout chips	864
Number of channels	110592
R-φ resolution	172μm
Z resolution	1811µm
Z pad size	6000μm
R-φ pad size	600μm

IST has entered production phase





IST CD-4 deliverables



- 27 (24+3 spares) staves with six sensors per stave
- 24 IST staves installed on the Middle Support Cylinder
- Silicon bias voltage system for 24 staves
- Readout system for 24 staves
- Cabling and Cooling Services

Delivered by March-April 2013

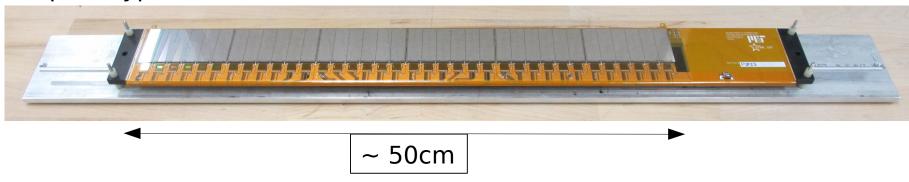




IST stave



IST prototype stave



IST stave = carbon fiber ladder + cooling tubes
kapton flex hybrid + passive components
6 silicon pad sensors

3 x 12 APV25-S1 readout chips

Electrically divided in 3 units to reduce chance of failure of a full stave

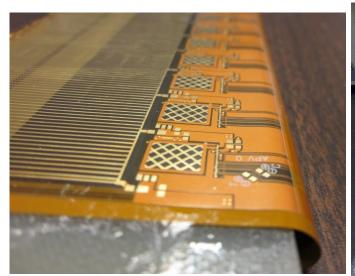
Full prototype stave assembled and tested

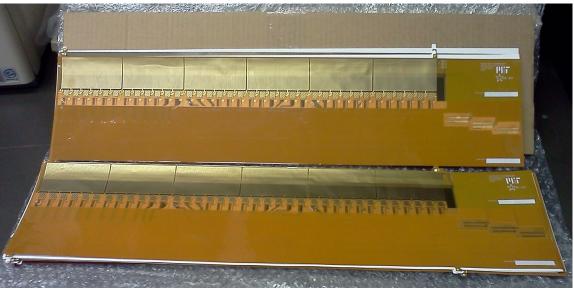




IST ladder and hybrid









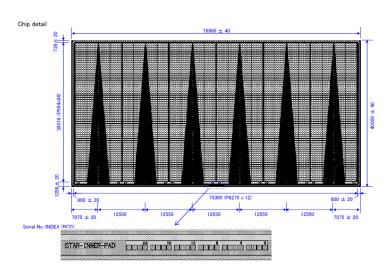
All hybrids produced and at LBNL for lamination with carbon fiber staves, ready end of August

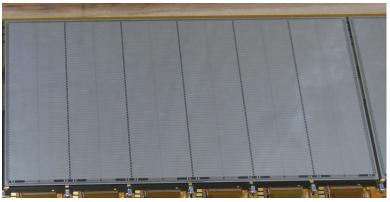


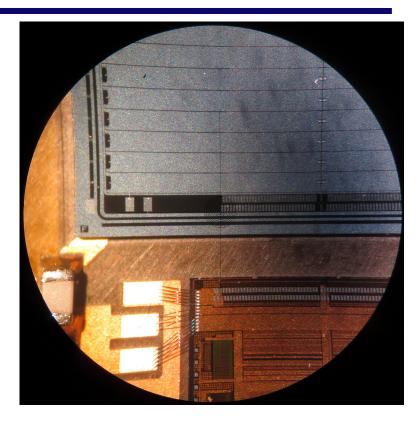


IST silicon pad sensor









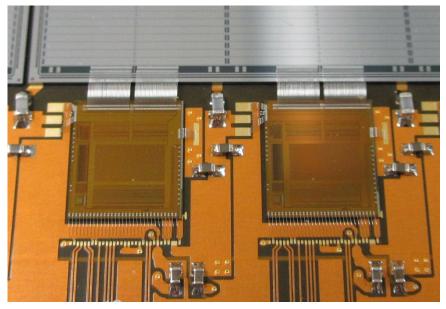
Silicon sensors in production, delivery starts in October





IST readout chip





APV25-S1

STAR use: - IST

- FGT

Developed for CMS (75,000 used in tracker) (used in COMPASS for triple GEM)

0.25 um CMOS Radiation hard

128 channels parallel sampling

40 MHz sampling rate

4 us analogue pipeline

< 30 us deadtime for 20 MHz 3-samp readout

Better than 15:1 signal to noise ratio

0.3 Watt per chip

All chips ready for mounting





IST prototype staves









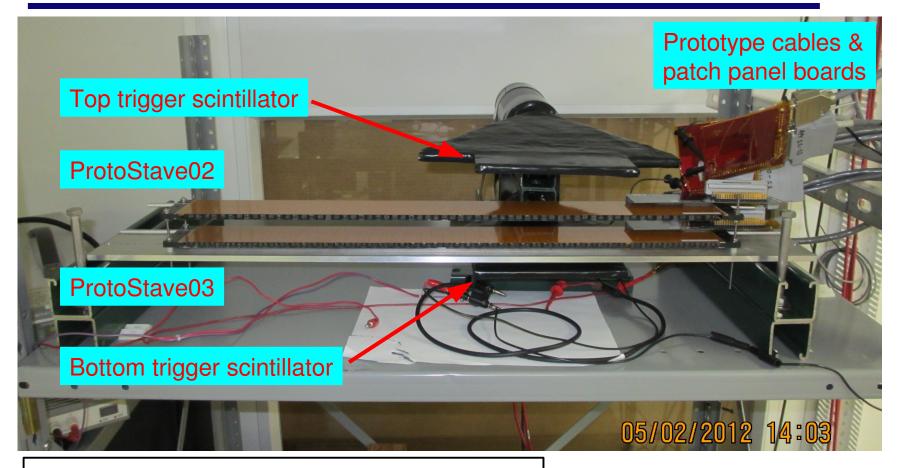
ProtoStave02, 36 APV's, 1 bonded sensor ProtoStave03, 36 APV's, 6 bonded sensors ProtoStave04, 12 APV's, 1 bonded sensor





IST Cosmic Ray Setup





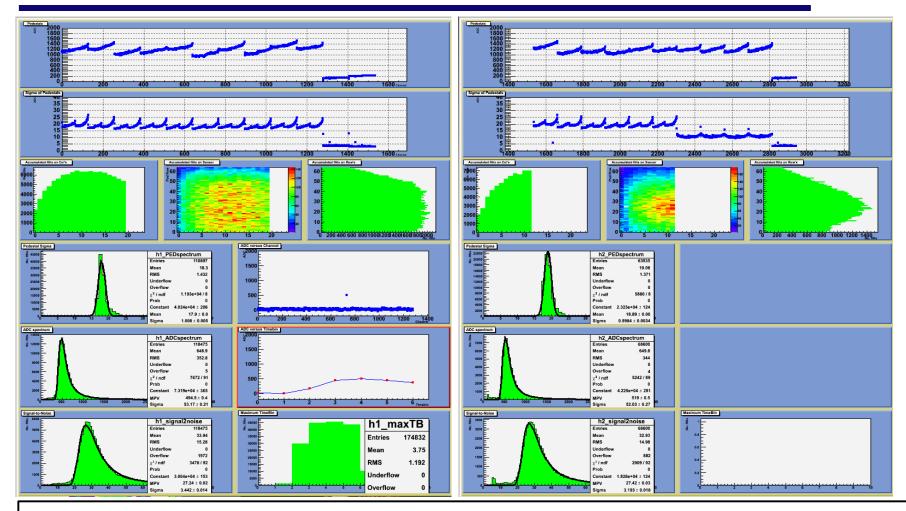
Works great at about 0.5Hz





IST Cosmic Ray Data I





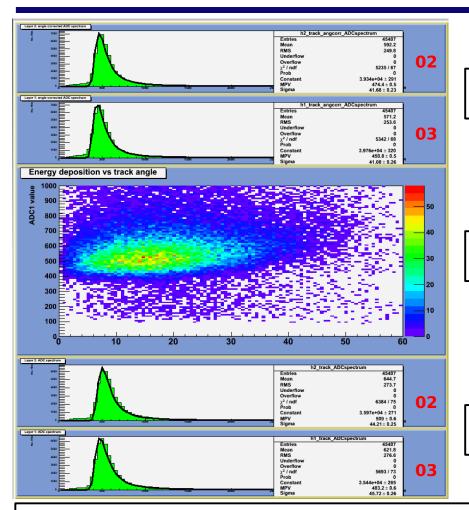
Everything works as expected, > 99% functional





IST Cosmic Ray Data II





After angle correction

Signal vs Angle

Before angle correction

Angle correction works as expected, S/N > 20:1





IST stave production



												1	
▼		Finish 💌	Cost 💌	September	October	November	December	January	February	March	April	May	June
☐ Batch 2, UIC/FIIAL assembly, 18 staves	Mon 9/17/12			-	1		 		_		Batch 2, Ul	C/FNAL assembly.	18 staves
Mount components on staves 1 to 9 (Proxy)	Mon 9/17/12	Fri 9/28/12	\$4,000.00		' L '	ents on staves 1 to	1 ' ['			1			
Mount components on staves 10 to 18 (Proxy)	Mon 10/1/12	Fri 10/12/12	\$4,000.00	1			aves 10 to 18 (Proxy)			1			
Mount readout chips stave 1 to 9 (FNAL tech 100%)	Mon 10/1/12	Fri 10/12/12	\$8,000.00	1			e 1 to 9 (FNAL tech			!			
Mount readout chips stave 10 to 18 (FNAL tech 100%)	Mon 10/15/12	Fri 10/26/12	\$8,000.00	1			i ps stave 1 0 to 18 (F	ľ	'	ļ			
Mount sensors staves 1 to 3 (FNAL tech 100%)	Mon 10/29/12	Wed 10/31/12	\$2,400.00	1		~	s staves 1 to 3 (FNAL			!			
Mount sensors staves 4 to 6 (FNAL tech 100%)	Mon 11/5/12	Wed 11/7/12	\$2,400.00	1			sors staves 4 to 6 (F	1	۱ ۱	1			
Mount sensors staves 7 to 9 (FNAL tech 100%)	Mon 11/12/12	Wed 11/14/12	\$2,400.00	1		Mount:	sensors staves 7 to	1	1	ļ			
Mount sensors staves 10 to 12 (FNAL tech 100%)	Fri 1/11/13	Tue 1/15/13	\$2,400.00	1		$\Pi \Pi \Pi \Pi$		— 1	sensors staves 1				
Mount sensors staves 13 to 15 (FNAL tech 100%)	Fri 1/18/13	Wed 1/23/13	\$2,400.00	1				T 🍋 🖖	ount sensors sta	I I '			
Mount sensors staves 16 to 18 (FNAL tech 100%)	Mon 1/28/13	Wed 1/30/13	\$2,400.00	1			+	🖺	*II I I	staves 16 to 1	8 (FNAL tech 100%)		
Wire bonding readout chips staves 1 to 3 (FNAL bonding tech 100%)	Mon 10/15/12	Fri 10/19/12	\$5,600.00	1			chips staves 1 to 3	. 1		!			
Wire bonding readout chips staves 4 to 6 (FNAL bonding tech 100%)	Mon 10/22/12	Fri 10/26/12	\$5,600.00	1		11 1 F	dout chips staves 41	1 11	17 1 1	ļ			
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Wire bonding sensors staves 4 to 6 (FNAL bonding tech 100%)	Mon 11/19/12	Tue 12/4/12	\$11,200.00	1		🏣	-1 1 -1		4 to 6 (FNAL bond				
Wire bonding sensors staves 7 to 9 (FNAL bonding tech 100%)	Wed 12/5/12	Tue 12/18/12	\$11,200.00	1			Wire bo	T II	staves 7 to 9 (FN)	I T			
Wire bonding readout chips staves 10 to 12 (FNAL bonding tech 100%)	Wed 12/19/12	Thu 1/3/13	\$5,600.00					**			FNAL bonding tech 10		
Wire bonding readout chips staves 13 to 15 (FNAL bonding tech 100%)	Fri 1/4/13	Thu 1/10/13	\$5,600.00					— I	11 1		15 (FNAL bonding te		
Wire bonding readout chips staves 16 to 18 (FNAL bonding tech 100%)	Fri 1/11/13	Thu 1/17/13	\$5,600.00	1			++++	Wire	onding readout	hips staves 16	6 to 18 (FNAL bonding	y tech 100%)	
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Wire bonding sensors staves 13 to 15 (FNAL bonding tech 100%)	Mon 2/4/13	Fri 2/15/13	\$11,200.00	1			++++	+ $+$ $+$ $+$	Wire b	-	rs staves 13 to 15 (FN	- 1	
Wire bonding sensors staves 16 to 18 (FNAL bonding tech 100%)	Mon 2/18/13	Mon 3/4/13	\$11,200.00				++++	+		Wire bondii	ng sensors staves 1	6 to 18 (FNAL bone	ling tech 100%)
Readout tests chips staves 1 to 3 (Zhenyu, UIC elec eng 50%)	Mon 10/22/12	Fri 10/26/12	\$2,000.00	1		_	ps staves 1 to 3 (Zhe	1 1	1-1	\			
Readout tests chips staves 4 to 6 (Zhenyu, UIC elec eng 50%)	Mon 10/29/12	Fri 11/2/12	\$2,000.00	1]]]	-	chips staves 4 to 6	1 1- 1	11 - 1				
Readout tests chips staves 7 to 9 (Zhenyu, UIC elec eng 50%)	Mon 11/5/12	Fri 11/9/12	\$2,000.00			Readout te	ests chips staves 7	1 - 1		!			
Test staves 1 to 3 (Zhenyu, UIC elec eng 50%)	Mon 11/19/12	Tue 11/27/12	\$2,000.00	1			Test staves 1 to 3 (\			
Test staves 4 to 6 (Zhenyu, UIC elec eng 50%)	Wed 12/5/12	Tue 12/11/12	\$2,000.00	1			Test stave:		, UIC elec eng 50%				
Test staves 7 to 9 (Zhenyu, UIC elec eng 50%)	Wed 12/19/12	Thu 1/3/13	\$2,000.00	1		1		TL	to 9 (Zhenyu, UIC				
Readout tests chips staves 10 to 12 (Zhenyu, UIC elec eng 50%)	Fri 1/4/13	Thu 1/10/13	\$2,000.00	1				Readout	ests chips stave:	s 10 to 12 (Zher	nyu, UIC elec eng 50%	5)	
Readout tests chips staves 13 to 15 (Zhenyu, UIC elec eng 50%)	Fri 1/11/13	Thu 1/17/13	\$2,000.00	1				Reado	out tests chips st	aves 13 to 15 (2	Zhenyu, UIC elec eng	50%)	
Readout tests chips staves 16 to 18 (Zhenyu, UIC elec eng 50%)	Fri 1/18/13	Fri 1/25/13	\$2,000.00			1		_ 	1 1 1	1	18 (Zhenyu, UIC elec		
Test staves 10 to 12 (Zhenyu, UIC elec eng 50%)	Mon 2/4/13	Fri 2/8/13	\$2,000.00	1		1			1 — I	I I I	enyu, UIC elec eng 50		
Test staves 13 to 15 (Zhenyu, UIC elec eng 50%)	Mon 2/18/13	Fri 2/22/13	\$2,000.00	1		1			**	st staves 13 to	o 15 (Zhenyu, UIC ele	s eng 50%)	
Test staves 16 to 18 (Zhenyu, UIC elec eng 50%)	Tue 3/5/13	Mon 3/11/13	\$2,000.00	1						Test st	taves 16 to 18 (Zheny	u, UIC elec eng 50	%)
Bonding rework I (FNAL bonding tech 100%)	Tue 3/12/13	Mon 4/8/13	\$22,400.00	1						<u>ا</u>	Bonding re	work I (FNAL bond	ing tech 100%)
Test reworked staves (Zhenyu, UIC elec eng 50%)	Tue 3/19/13	Mon 4/8/13	\$6,000.00	1				1		\ \	Test rewor	ked staves (Zhen	yu, UIC elec eng ≸0%
Survey staves (Zhenyu, FNAL tech 10%)	Fri 1/4/13	Mon 3/18/13	\$4,000.00	1						Sur	rvey staves (Zhenyu,	FNAL tech 10%)	
							A						

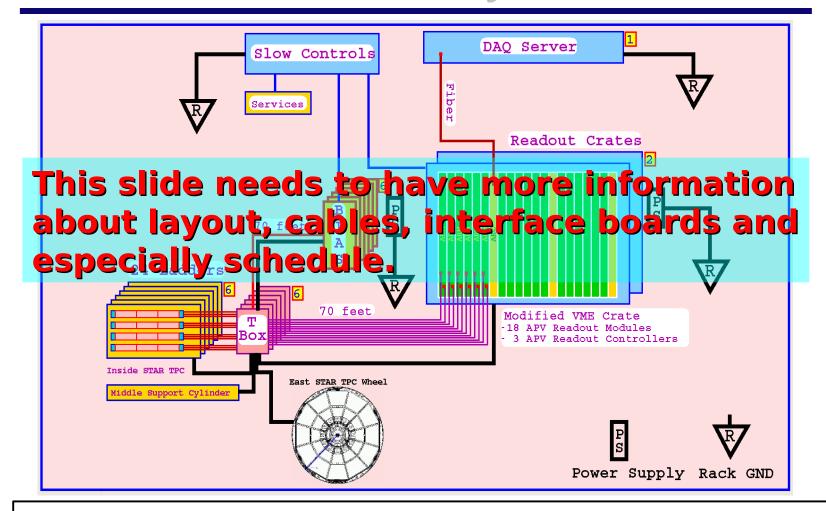
Production at MIT/BNL & UIC/FNAL, ready Mar/Apr





IST readout system





Design 80% done, almost identical to FGT design





IST readout crate





Worked satisfactory for FGT in RHIC Run 12

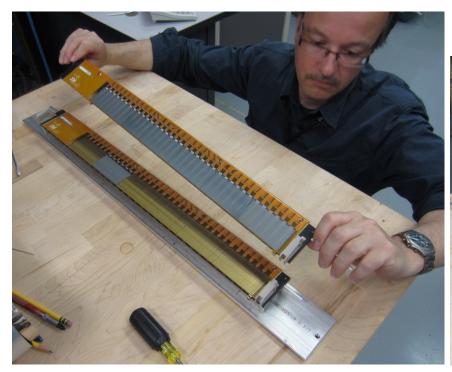
Crate, ARM and ARC design 90% done

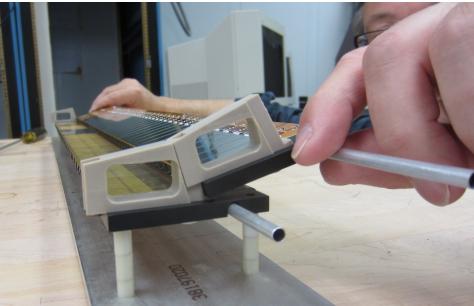




IST stave supports







Individual PEEK pieces support the staves





IST milestones



Level	Milestone	Planned	Actual/ Forecast
		Fiailileu	
	CD-0 Approve Mission Need		2/18/09 (A)
1	CD-1 Approve Alternative Selection and Cost Range		8/31/10 (A)
1	CD-2 Approve Performance Baseline	Q4FY11	Aug-11
1	CD-3 Approve Start of Fabrication	Q4FY11	Aug-11
1	CD-4 Approve Project Completion	Q3FY15	Jun-15
1.3	IST		
2	Sensor design Finished	Q1FY12	Jul-11
2	Prototype ladder tested	Q2FY12	Dec-11
2	Flex hybrid produced	Q3FY12	Feb-12
2	First staves produced	Q4FY12	- Jun 12
2	Staves finalized	Q2FY13	- Nov-12
2	IST assembled onto MSC	Q4FY13	Mar-13

First three L2 milestones met Will miss next milestone, but mitigation in place through doubling of production capability





IST cost by Level 3 WBS



WBS	VBS Task Name	
1.3	Intermediate Silicon Tracker (IST)	2,480
1.3.1	Mechanics	599
1.3.2	Electronics	1,122
1.3.3	Assembly, testing and installation	759

Waiting for official Sarah stuff.





IST human resources



Name	Function	Affiliation	Expertise
Bernd Surrow	Physicist	MIT	Sub system manager
Gerrit van Nieuwenhuizen	Physicist	MIT	Detector development
Ben Buck	Electronics Engineer	MIT-Bates	Front End Electronics, Readout
OK, so this no Gerard Visser	Electronics Engineer	Jerious	ly re-done Readout, DAQ
Jim Kelsey	Mechanical Engineer	MIT-Bates	Support Structure, Cooling
Jason <u>Bessuille</u>	Mechanical Engineer	MIT-Bates	Support Structure, Cooling
Eric <u>Anderssen</u>	Mechanical Engineer	LBNL	Support Structure
Dale Ross	Technician	MIT-LNS	Assembly
TBD	Technician	MIT	Assembly *2
TBD	Technician	MIT/BNL	Wire Bonding
Don <u>Pinelli</u>	Technician	BNL	Wire Bonding

+ UIC crowd and FNAL technicians + Bob Soja





IST risk assessment



	WBS	Risk description	Mitigation Strategy	Level
	1 4 1 4 5	Ladder production delay	scheduling slack	moderate impact low severity
	1.3.2.2.3	Prototype sensors specification failure	scheduling slack,reliable vendor	moderate impact moderate seventy
	1.3.2.2.4	Flex hybrid prototype scheduling slack, less prototypes		moderate impact moderate severny
Ф	1.3.2.3.1	Sensor production problems	reliable vendor, stage batch production	moderate impact low severity
risk table	1.3.2.3.3	Flex hybrid production problems	scheduling slack by producing early	moderate impact BEJERED
IST	1.3.2.3.6	Readout system problems	Problems straightened out by FGT	RETIRED
of the full	1.3.3.3	Stave assembly problems	Establish conservative assembly pipeline	moderate in pact moderate seventy
Part of	1.3.3.4	Layer integration problems	Scheduling slack, delay installation	moderate impact low severity

All risks low to moderate, mitigation strategies in place





Summary



- Designs for staves 100% complete
- Designs for readout system 90% complete
- Stave prototypes functioned as expected
- Fabrication plan modified to mitigate schedule delays
- Resources are sufficient to satisfy the schedule
- The risk severity is low to moderate for all major subsystem tasks, mitigation strategies are in place or activated already and many risks have been retired





Backup slides

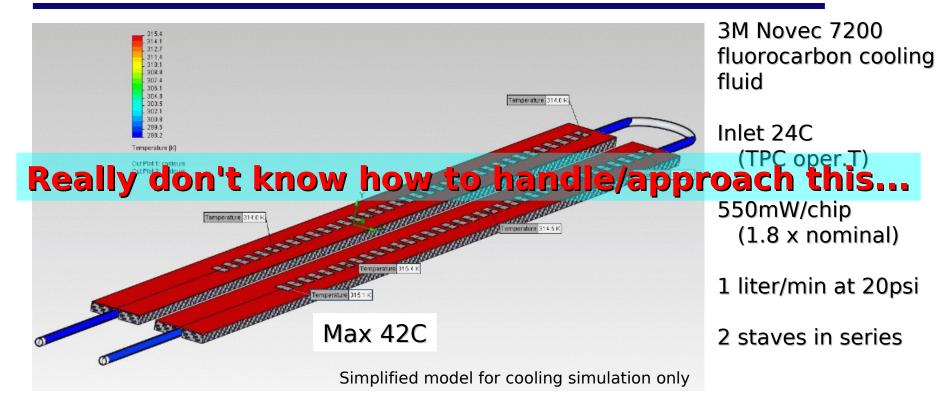






IST cooling





Simulations show 42C max at chips with 1.8x the nominal dissipation and no cooling via's through Kapton hybrid yet **Actual temperature will be lower**



